(124)

DESIGN EVALUATION/QUALIFICATION TEST OF END FITTINGS (DESTRUCT KIT)

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DOUGLAS REPORT SM-42503

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ABSTRACT

This test report was prepared by the Douglas Aircraft Company for the National Aeronautics and Space Administration to present the design evaluation/qualification test results of end fitting assemblies, including the method of attachment to linear shaped charge and detonating cord. The end fittings comprise a portion of a destruct kit used on the Saturn S-IV stage. The assembly consists of segments of detonating cord or linear shaped charge, booster charges, caps, nuts, and sleeves. The detonating cord assembly (Douglas P/N LA009218) utilizes an explosive manufactured by the Ensign-Bickford Product Division of Darworth, Inc., Simsbury, Connecticut, (PETN 340 Plastic HV Primacord), 60 grains per foot. The linear shaped charge assemblies (Douglas P/N LA009216 and P/N LA009217) also utilize an explosive manufactured by Ensign-Bickford (P/N FLSC-3-100-AL-J), 100 grains per foot. These parts were subjected to destruct tests and drop tests to determine the effects of various end fitting air gaps on their propagation capabilities and to determine impact sensitivity. It was successfully demonstrated that the end fittings and methods of attachment to linear shaped charge and detonating cord propagates the detonation wave across a gap.

LIBRARY REFERENCE DESCRIPTORS

Saturn S-IV
Charge
Destruct
Detonation
Disintegration
Drop Test
Evaluation
Gap
Initiating
Linear
Propagation
Sensitivity

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1. INTRODUCTION

This report describes the scope, details, and results of design evaluation/qualification tests conducted by Douglas Aircraft Company on end fittings with detonating cords and linear shaped charges which comprise a portion of a destruct kit for use on the Saturn S-IV stage. The test assemblies (Douglas P/N's 1A00916, 1A00917, and 1A00918) are identical to the type to be installed on the stage, except for the length of the detonating cord and the shaped charge. The purpose of these tests was to determine, (a) the effect of various air gap spacings on the propagation of the detonation between end fitting assemblies, (b) to determine the impact sensitivity of the end fittings, the detonating cord, and the linear shaped charge, in order to evaluate the design integrity and to approve these parts for use on the Saturn S-IV stage.

2. TEST PARTS AND EQUIPMENT

2.1 Test Parts

The following test parts were used in the performance of the tests:

a. Seventeen End Fitting Test Assemblies, Douglas P/N 1A00916.
b. Eight End Fitting Test Assemblies, Douglas P/N 1A00917.
c. Fifteen Detonating Cord Test Assemblies, Douglas P/N 1A00918.

2.2 Test Equipment

The following test equipment was used in the performance of the tests:

a. No. 6 blasting caps.
b. One 45 volt battery.
c. One 10 pound weight.
d. Associated cable and tubing.

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3. TEST REQUIREMENTS

3.1 Gap Tolerance Tests

The linear shaped charge shall be assembled to the detonating cord assembly by fully threading Douglas P/N 1A00916 and P/N 1A00918 together as shown in figure 1. This should provide an air gap of 0.030 ± 0.010 inch between Douglas P/N 2884894-1 nut and P/N 4884324-1 sleeve. Index Douglas P/N 2884890-1 nut and P/N 4884324-1 sleeve and back off nut until a total air gap of 0.1875 inch is obtained. Fire three assemblies by initiating the linear shaped charge with a No. 6 blasting cap.

3.1.1 Repeat paragraph 3.1 except initiate the detonating cord.

3.1.2 Repeat paragraph 3.1 except use air gaps of 0.0625 and 0.125 inch.

3.1.3 Further tests may be conducted using air gaps of 0.2225, 0.3188, and 0.3875 inch provided propagation occurs across the 0.1875 inch gap, This will then delete the requirements for the 0.0625 and 0.125 inch tests as noted in paragraph 3.1.2.

3.2.1 The linear shaped charge assembly shall be connected by fully threading Douglas P/N 1A00916 and P/N 1A00917 together as shown in figure 2. An air gap of 0.030 ± 0.010 inch should exist between Douglas P/N 2884893-1 sleeve and P/N 2884894-1 cap. Back off nut to obtain a total air gap of 0.1875 inch and bottom cap against shoulder of nut. Retain nut in order to insure the air gap setting. Three assemblies shall be initiated by using No. 6 blasting caps for initiation. If successful propagation occurs across the 0.1875 inch gap in paragraph 3.1, this requirement may be deleted.

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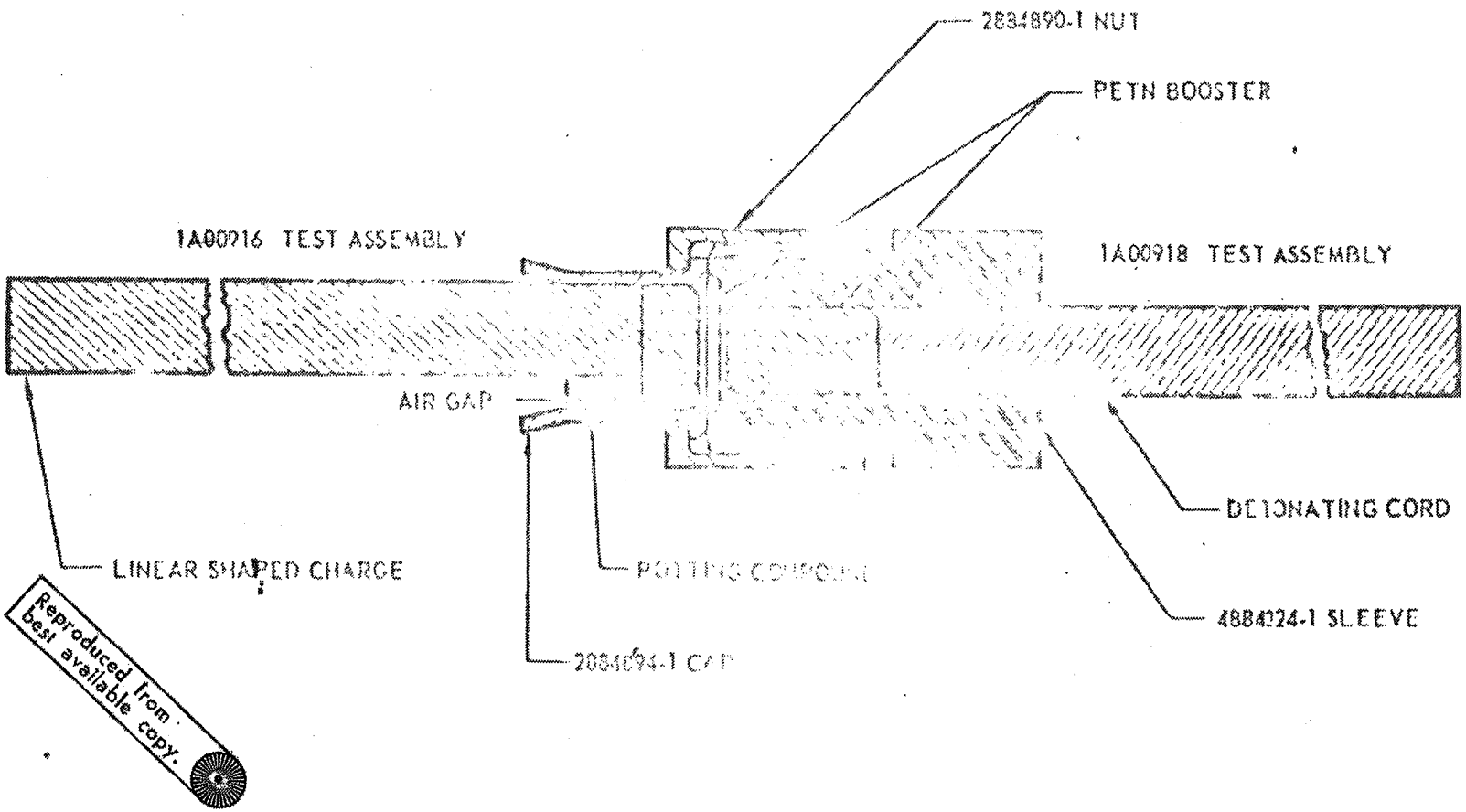
3.2.2 Repeat paragraph 3.2.1 except use air gaps of 0.0625 and 0.125 inch.

3.2.3 Further tests may be conducted using air gaps of 0.2225, 0.3188, and 0.3875 inch provided propagation occurs across the 0.1875 inch gap.

CROSS SECTION OF COMPONENTS IN THE
LINEAR SHAPED CHARGE TO DETONATING
CORD TEST (FULLY THREADED)



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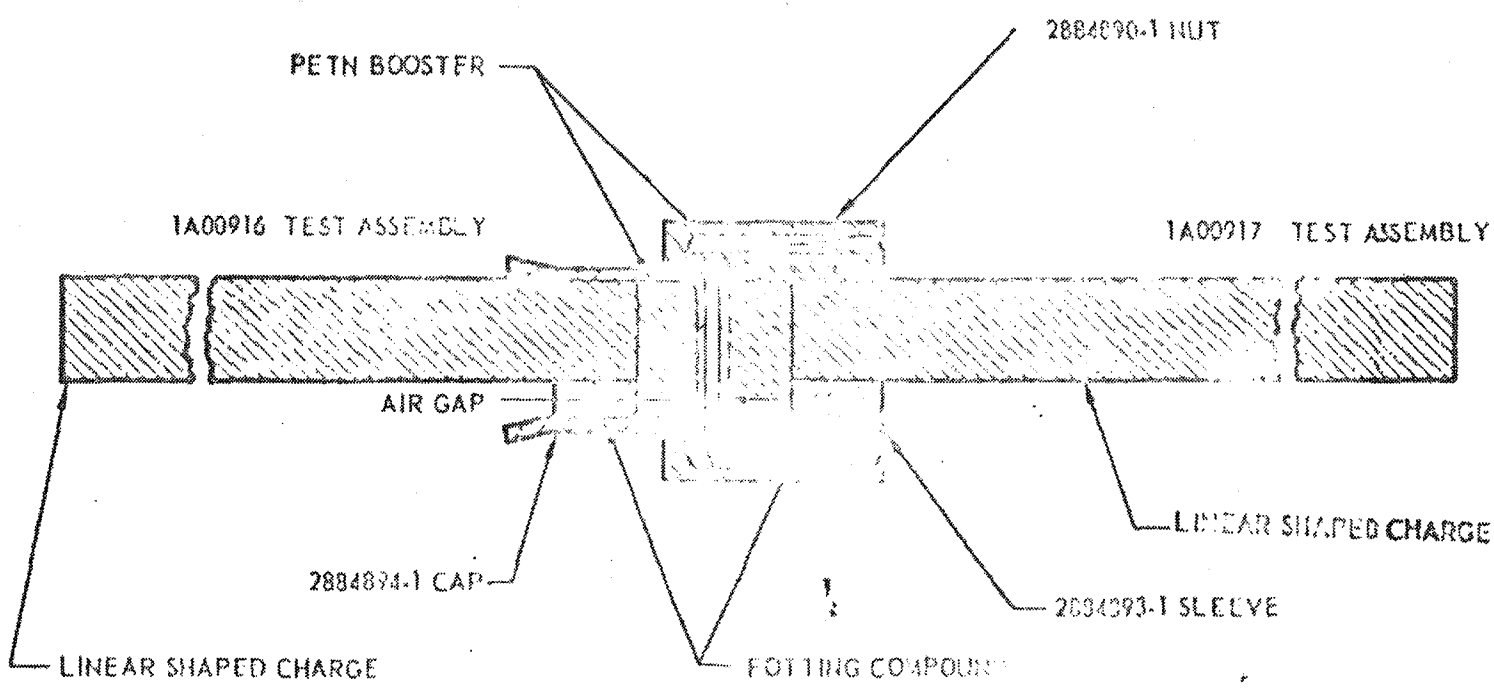
NO SCALE

FIGURE 1

CROSS SECTION OF COMPONENTS IN THE
LINEAR SHAPED CHARGE TO LINEAR
SHAPED CHARGE TEST (FULLY THREADED)



NO SCALE

FIGURE 2

This will then delete the requirements for the 0.0625 and 0.125 inch tests as noted in paragraph 3.2.2.

3.2.4 Complete detonation and propagation shall occur at all fittings, charges, and detonating cords in all tests described above.

3.3 Impact Sensitivity Tests

3.3.1 A 10 pound weight (preferably a round bar) shall be dropped from a height of 15 feet on 3 each of test specimens manufactured to Douglas drawings 1A00916 and 1A00917, and 6 each of test specimens manufactured to Douglas drawing 1A00918. Detonation shall not occur.

3.3.2 A 10 pound weight (preferably a round bar) shall be dropped from a height of 15 feet on the fitting end and then on the shaped charge section of 2 each of test specimens manufactured to Douglas drawings 1A00916 and 1A00917. Detonation shall not occur.

4. TEST PROCEDURES

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4.1 End Fitting Air Gap Tests

4.1.1 The linear shaped charge assembly, P/N 1A00916 was fully threaded to the detonating cord assembly P/N 1A00918. See figure 1. The nut was then backed off 2.9 turns to establish an air gap of 0.1875 inch. Both units were taped to a steel plate to insure that the cap, P/N 2884894-1, was bottomed against the shoulder of the nut, P/N 2884890-1. A No. 6 blasting cap was installed at the end of the linear shaped charge. The assembly was then detonated. This procedure was repeated three times. See table 1.

4.1.2 Same as 4.1.1 above, except that the blasting cap was installed at the end of the detonating cord.

4.1.3 Same as 4.1.1 above, except that the nut was backed off 3.5 turns to establish an air gap of 0.2225 inch. Only one firing was made, with the blasting cap installed at the end of the detonating cord.

TABLE I

EFFECTS OF END FITTING AND GAPS

TEST NO.	SHOT NO.	GAP END FITTINGS (INCHES)	END FITTING P/N	END FITTING P/N	NO. 6 BLASTING CAP LOCATION	REMARKS
1	1	0.1875	1A00916	1A00918	1A00916	PROPAGATION COMPLETE (NORMAL)
	2	0.1875	1A00916	1A00918	1A00916	NORMAL
	3	0.1875	1A00916	1A00918	1A00916	NORMAL
	4	0.1875	1A00916	1A00918	1A00918	NORMAL
	5	0.1875	1A00916	1A00918	1A00918	NORMAL
	6	0.1875	1A00916	1A00918	1A00918	NORMAL
2	1	0.2225	1A00916	1A00918	1A00918	NORMAL
	2	0.2225	1A00916	1A00917*	1A00917	NORMAL
	3	0.3188	1A00916	1A00918	1A00918	NORMAL
	4	0.3188	1A00916	1A00917*	1A00917	NORMAL
	5	0.3075	1A00916	1A00918	1A00918	NORMAL
	6	0.3875	1A00916	1A00917*	1A00917	NORMAL

*DENOTES LINEAR SHAPED CHARGE

TABLE 2

IMPACT SENSITIVITY RESULTS

TEST NO.	SHOT NO.	PART NO.	POINT OF IMPACT	REMARKS
3	1	1A00918	END FITTING	SLIGHT DETONATION, AT END FITTING ONLY
	2	1A00918	END FITTING	NO DETONATION – NO PROPAGATION
	3	1A00918	END FITTING	NO DETONATION – NO PROPAGATION
	4	1A00917	END FITTING	NO DETONATION – NO PROPAGATION
	5	1A00917	END FITTING	SLIGHT DETONATION, AT END FITTING ONLY
	6	1A00917	END FITTING	NO DETONATION – NO PROPAGATION
	7	1A00916	END FITTING	COMPLETE DETONATION AND PROPAGATION
	8	1A00916	END FITTING	SLIGHT DETONATION, AT END FITTING ONLY
	9	1A00916	END FITTING	SLIGHT DETONATION, AT END FITTING ONLY
4	1	1A00918	END FITTING	NO DETONATION – NO PROPAGATION
	2	1A00918	END FITTING	NO DETONATION – NO PROPAGATION
	3	1A00918	END FITTING	NO DETONATION – NO PROPAGATION
	4	1A00917	END FITTING	SLIGHT DETONATION, AT END FITTING ONLY
	5	1A00917	SHAPED CHARGE	SLIGHT DETONATION – PROPAGATION AT POINT OF IMPACT ONLY
	6	1A00917	SHAPED CHARGE	SLIGHT DETONATION – PROPAGATION AT POINT OF IMPACT ONLY
	7	1A00917	END FITTING	SLIGHT DETONATION, AT END FITTING ONLY
	8	1A00916	END FITTING	SLIGHT DETONATION, AT END FITTING ONLY
	9	1A00916	SHAPED CHARGE	SLIGHT DETONATION – PROPAGATION AT POINT OF IMPACT ONLY
	10	1A00916	SHAPED CHARGE	NO DETONATION – NO PROPAGATION
	11	1A00916	END FITTING	SLIGHT DETONATION, AT END FITTING ONLY

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4.1.4 Same as 4.1.3 above, except that a shaped charge assembly, P/N LA00917 was used in place of a detonating cord assembly, P/N LA00918. See figure 2. A No. 6 blasting cap was installed at the end of the shaped charge.

4.1.5 Same as 4.1.3 above, except the nut was backed off 5.25 turns to establish an air gap of 0.3188 inch.

4.1.6 Same as 4.1.4 above, except with air gap of 0.3188 inch.

4.1.7 Same as 4.1.3 above, except nut was backed off 6.5 turns to establish an air gap of 0.3875 inch.

4.1.8 Same as 4.1.4, above, except with an air gap of 0.3875 inch.

4.2 Impact Sensitivity Tests

4.2.1 A 10 pound weight (round bar) was dropped from a height of 15 feet on the fitting end of 3 each of P/N LA00916 assemblies, 3 each of P/N LA00917 assemblies, and 6 each of P/N LA00918 test specimens. See table 2.

4.2.2 A 10 pound weight was dropped from a height of 15 feet on the fitting end and then on the shaped charge section on 2 each of P/N LA00916 assemblies and 2 each of P/N LA00917 assemblies. See table 2.

5. TEST RESULTS

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5.1 End Fitting Air Gap Tests

Tabulated results of end fitting air gap tests are contained in table 1. Test No. 1 included six shots with a maximum air gap of 0.1875 inch. In all six cases complete propagation, detonation, and disintegration (designated as normal) resulted, leaving minute metal and fiber residue. From the above results it was decided that further testing utilizing smaller air gaps was unnecessary. Test No. 2 included six shots with progressive air gap increases from 0.2225 to 0.3875 inch. Complete propagation, detonation, and disintegration resulted in all shots. To

establish an air gap of 0.3875 inch, only one-half thread engagement between P/N 2884d90-1 nut and P/N 2884893-1 sleeve was required.

5.2 Impact Sensitivity Tests

Tabulated results of impact sensitivity tests are contained in Table 2. Twenty drop tests were made, using assemblies P/N LA00916, P/N LA00917, and P/N LA00918. Eight tests resulted in no detonation or propagation, while eight tests resulted in slight detonation at the end fittings with no propagation beyond the fitting. In three impact tests on the linear shaped charge, there was slight detonation at the point of impact only. Only one of the twenty tests resulted in complete detonation and disintegration of the test assembly. This occurred in assembly P/N LA00916.

6. TEST CONCLUSIONS

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Based upon the design evaluation/qualification test results presented in this report, it is the conclusion of the Douglas Aircraft Company that the destruct kit end fitting assemblies and the method of attachment to linear shaped charge and detonating cord has successfully met the test requirements outlined in Section 3, Test Requirements, and are approved for use on the Saturn S-IV stage. It is concluded that these assemblies are safe from accidental initiation caused by impact of dropped parts or tools. The ends are covered with protective caps at any time that it is possible to drop an assembly more than 10 feet in height. However if the present S-IV handling and checkout procedures for the destruct kit are not adhered to, minor explosions of the end fittings may result.

APPROVAL SHEET

REPORT NO. SM-42503

DESIGN EVALUATION/QUALIFICATION TEST
OF FWD FITTINGS (DESTRUCT KIT)

MODEL NO. SATURN S-IV

20 November 1962

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